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THE FUMIGATION OF TOBACCO WAREHOUSES

By W. D. Reed, E. M. Livingstone, and A. W. Morrill, Jr.,
Division of Truck Crop and Garden Insects, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture

Introduction

The principal insects attacking cured tobacco are the cigarette beetle (Lasioderma serricorne Fab.) and the tobacco moth (Ephestia elutella Hbn.). During recent years the tobacco moth has assumed a position of importance as a tobacco pest. A survey of the industry has shown that these insects have a decided taste or preference for the cigarette-type tobaccos with high sugar content, and that the greatest losses are sustained by manufacturers and dealers handling these tobaccos.

The cigarette industry has increased at an enormous rate during the last few years. For example, during the ten-year period of 1921 to 1930 the total output of cigarettes in the United States increased over 250 percent. This rapid growth has increased to a similar degree the quantity of tobacco held in storage by manufacturers. Before tobacco is manufactured into cigarettes it is held in storage from 2 to 4 years, or longer. Tobacco dealers also often hold tobacco for long periods before it is exported. During long periods in storage, heavy losses result from insect infestations unless effective control measures are carried out.

The open type tobacco warehouse consists of sheet metal walls, which have large ventilators running the entire length of the building, gravel or composition roofs, and floors of concrete or wood. This type of building cannot be fumigated effectively unless the walls and floors are lined with gas-proof material. Insect control in open storages must be effected with insect traps or other devices; however, these methods of control will not receive attention in this paper. Closed storages are constructed ordinarily of brick walls, concrete or wood floors, and gravel or composition roofs. Warehouses are often separated by fire walls into sections, each containing from 150,000 to 350,000 cubic feet. A few closed storages in the bright-tobacco belt are constructed of reinforced concrete; also in some instances old factory buildings have been converted into closed tobacco storages. This paper contains recommendations for the atmospheric fumigation of closed storages as a control measure for insects that attack cured tobacco, and the recommendations are based on experiments conducted by the writers to date.

Available fumigants for tobacco

A considerable number of materials are used for commercial fumigation, but only a few have been applied to any extent in the tobacco industry. The gases generally used are hydrocyanic acid, ethylene oxide-carbon dioxide mixture, methyl formate-carbon dioxide mixture, and carbon disulphide. The last-named gas is inflammable and explosive when mixed with air, and special permission must be obtained from fire insurance companies for its use. All of the above-mentioned materials form gases at ordinary temperatures and will evaporate when exposed to air. Hydrocyanic acid and carbon disulphide are the most widely used fumigants for tobacco, both in warehouses and in especially constructed apparatus for fumigation. The other gases mentioned are used to some extent for the fumigation of tobacco in well-constructed chambers or in steel vacuum tanks.

The most widely used fumigant for controlling infestations of cured-tobacco insects in warehouses is hydrocyanic acid gas. This gas is obtained from liquid hydrocyanic acid, sodium cyanide, various calcium cyanides, and a number of preparations in which liquid hydrocyanic acid is absorbed in diatomaceous earth or in thin discs of bibulous paper or wood pulp.

Liquid hydrocyanic acid

Hydrocyanic acid is marketed for commercial fumigation in steel cylinders, each containing 75 pounds or 30 pounds, which meet the requirements of the Interstate Commerce Commission. Storages to be fumigated are ordinarily equipped with $\frac{1}{4}$-inch copper piping (and one disc nozzle for each 25,000 to 30,000 cubic feet of warehouse space) which leads to the outside of the storage, thus permitting all handling of the gas to take place outside the building. Such piping installation is permanent, and the labor and materials cost approximately 10 cents for each 1,000 cubic feet of space to be fumigated. Since liquid hydrocyanic acid is a highly concentrated poison, guaranteed by manufacturers to be 95 to 98 percent HCN, it must be handled with great care. A fumigator should be trained especially for handling liquid HCN, or tobacco companies should employ responsible commercial fumigators who are competent to apply the acid and supervise the ventilation of the warehouses. Careless, ignorant, or reckless persons should never attempt the application of liquid hydrocyanic acid in tobacco warehouses.

Each steel cylinder of hydrocyanic acid is equipped with two valves; one is an outlet valve from which a steel tube leads directly to the bottom of the tank, the other opens directly into the cylinder. Air is forced into the tank through the latter valve until sufficient pressure is obtained to force the liquid HCN into the building through the piping system. The pressure required is usually 75 to 100 pounds per square inch. The liquid HCN is forced through the copper pipes and sprayed into the air space through small disc nozzles; and, at ordinary temperatures,

all of the acid is converted immediately into hydrocyanic acid gas. A section of a tobacco warehouse being fumigated with liquid hydrocyanic acid is shown in Figure 1. Additional information concerning the piping of warehouses and the application of hydrocyanic acid may be secured from the Tobacco Insect Laboratory, Bureau of Entomology and Plant Quarantine, 3303 Floyd Avenue, Richmond, Va.

Directions for sealing warehouses

In many instances poor results are obtained in the fumigation of tobacco storages because of inefficient methods of sealing, prior to releasing the fumigant. It has been observed in some cases that no attempt had been made to seal around the eaves and skylights of buildings. Windows, doors, ventilators, and elevator shafts should be well sealed also, if a concentration of gas is to be retained for a satisfactory length of time. Various grades of waterproof paper, tar paper, durable cardboard, and elastic roofing cement have been used successfully in the sealing of windows, ventilators, elevator shafts, skylights, and eaves of buildings. A good grade of paperhanger's paste has been found to be most satisfactory for sealing paper and cardboard to walls. A mixture of 4 parts of asbestos and 1 part of calcium chloride, with enough water to make a stiff dough, has been used successfully for sealing around doors1/ (see fig. 1). It is recommended that extreme care be given to the sealing of warehouses prior to fumigations.

Dosage recommendations for hydrocyanic acid

Since 1930, data have been secured on the percent killed in test lots of various stages of the cigarette beetle and the tobacco moth when the following dosages of liquid HCN per 1,000 cubic feet were applied: 4, 6, 7, 8, 10, 12, 14, 15, 16, 20, 21, and 24 ounces. It is not the purpose of this paper to present the details of this experimental work, but to discuss briefly the results obtained and to make recommendations regarding dosages based on results of experiments up to this time. Table 1 presents a scale of dosages, based on the results obtained with hydrocyanic acid against the cigarette beetle, when the specified dosages were used.

1/ This method of sealing doors of tobacco warehouses was devised at the Tobacco Insect Laboratory in 1931 during experimental fumigations.

Table 1. - Dosages of liquid hydrocyanic acid for killing all stages of the cigarette beetle, compiled from data obtained in the fumigation of tobacco warehouses, with maximum temperatures ranging from 70° to 90° F. and minimum temperatures ranging from 60° to 70° F., 1930 to 1933

Dosage of liquid HCN per 1,000 cubic feet: Ounces	Minimum exposure: Hours	Degree of control
4	48	Unsatisfactory.
6	48	Satisfactory in air space of storage.
7	48	do.
8	48	do.
10	48	Satisfactory in air space and to a depth of 3 inches in the hogsheads of tobacco.
12	48	do.
14	48	do.
16	72	Satisfactory in air space and to a depth of 6 inches in the hogsheads of tobacco.
18	72	do.
20	72	do.
24	72	do.

As shown in Table 1, the degree of control was found to be unsatisfactory when a dosage of 4 ounces of liquid HCN per 1,000 cubic feet was applied. In some tests, in which this dosage was used, incomplete kills were obtained in test lots of adults and larvae placed outside the tobacco hogsheads. No appreciable amount of penetration, as shown by the

percent killed in test lots, was obtained until a dosage of 10 ounces of liquid HCN per 1,000 cubic feet was applied. In a number of experiments satisfactory control was obtained to a depth of 3 inches from the staves of hogsheads of tobacco when a 10-ounce dosage was used. In well-sealed buildings satisfactory penetrations were often obtained to a depth of 6 inches into the tobacco when dosages of 16 ounces per 1,000 cubic feet were applied. Owing to the leakage factor, it is not considered practicable to use a dosage of liquid HCN exceeding 16 ounces per 1,000 cubic feet when fumigating tobacco warehouses. Although experiments were conducted with dosages ranging from 16 to 24 ounces per 1,000 cubic feet, the increased penetration and degree of control obtained did not justify the added expense of these higher dosages.

Sodium cyanide

Sodium cyanide (96-98 percent) is a white crystalline substance which is prepared for use in fumigation in small egg-shaped lumps, weighing about 1 ounce each, or as a crystalline solid. This material must be mixed with sulphuric acid (H_2SO_4) and water in order to generate hydrocyanic acid gas, and for this purpose it is advisable to use a stone crock or wooden barrel as the container. This is the so-called "pot" or "barrel" method of fumigation, which is used to some extent for the fumigation of tobacco in small warehouses or fumigation rooms.

The above chemicals should be mixed in the crock or barrel according to the following formula:

Sodium cyanide	1 pound
Sulphuric acid	1½ pints
Water	2 pints

The most satisfactory small container is a stone crock of 4-gallon capacity, but, to prevent spattering, not more than 3 pounds of sodium cyanide should be used to each crock. The most suitable generator for tobacco fumigation is a 50-gallon water-tight wooden barrel; oil barrels are more satisfactory than barrels in which paint or glue has been stored. Not over 30 pounds of sodium cyanide should be placed in one barrel. The barrels should be placed in tin tubs containing a few inches of water to which about 24 ounces of baking soda (sodium bicarbonate) or washing soda (sodium carbonate) has been added. The soda will neutralize the acid in case any excessive boiling occurs during the generation of the HCN gas. A suitable container for use in this work is shown in Figure 2.

Dosage of sodium cyanide

It has been found that a dosage of 2½ pounds of sodium cyanide per 1,000 cubic feet was required to give results that equal those from the use of 1 pound of liquid HCN in the fumigation of hogsheads of tobacco. Sodium cyanide in the 1-ounce egg-shaped balls contains approximately 52 percent available hydrocyanic acid, and in some instances about 10 percent may be retained in the residue. The area of space to be fumigated should be computed in cubic feet, and the proper number of generators to accommodate the sodium cyanide required placed accordingly.

Placing of chemicals in generators

The required amount of water should first be added to the barrel or crock, followed by the sulphuric acid, which must be poured into the water with care. If this order is reversed, the water being poured into the acid, the reaction is violent, and the operator may be severely burned by the spattering of the acid-water mixture. The charge of sodium cyanide should be placed in double-thickness paper bags and a bag placed beside each barrel or crock before the fumigation is started. When the sealing is completed, except for an exit, the bags of cyanide should be placed in the acid-water mixture, the operator should leave the room promptly, and the exit be closed and sealed from the outside.

The sulphuric acid in the mixture decomposes the paper bags containing the sodium cyanide, and the reaction is immediate. Heat is produced in the container, and the gas mixed with steam has the appearance of a bluish smoke as it escapes from the barrels. The odor of hydrocyanic acid gas has been described as resembling that of peach kernels.

Except in very small fumigations where only one or two generators are used, operators should wear gas masks while dropping the sodium cyanide. A gas mask should be available during all fumigations of tobacco warehouses, and must be equipped with chemicals suitable for neutralizing hydrocyanic acid gas or carbon disulphide. No canister should be used on a gas mask unless it is properly fortified chemically. There are special canisters for use with different gases, and fumigators should specify the gas with which the canister is to be used. Information concerning gas masks can be obtained from manufacturers of fumigants.

Disposal of residue after fumigation

After the fumigation room or storage is thoroughly ventilated, the residue in the barrels or crocks should be emptied promptly. When the generator is moved and the liquid residue shaken about, small amounts of gas may be given off. The operator should breathe as little as possible, therefore, while moving the barrels or crocks and should not hold his head over the container. The residue should be buried several feet in the soil and should be well covered. It is sometimes disposed of by being dumped into sewer drains.

Hydrocyanic acid in discs of absorbent material

Liquid HCN is absorbed in wafer-like discs made of bibulous paper or wood pulp, each containing about ½ ounce of hydrocyanic acid. These discs are packed in sealed tin containers of various sizes and are sold on the basis of the net content of hydrocyanic acid. This form of HCN is used in small fumigation rooms and does away with the necessity of using chemicals and generators as in the "pot" or "barrel" method.

The operator applying these discs must wear a gas mask. The cans should be opened with a special can opener which makes a clean rim cut.

The discs may be scattered over the floor or on the hogsheads and cases of tobacco. There is no HCN residue left in the discs and they may be disposed of with safety after the room is thoroughly ventilated. A gas mask should be worn by the operator when opening cans or applying the discs for fumigation, and the canister of the mask must contain the proper chemicals for neutralizing hydrocyanic acid gas.

Calcium cyanide

Calcium cyanide is a granulated material packed in tin containers of various sizes. On exposure to the air the granules absorb moisture, and in the chemical reaction that takes place the hydrocyanic acid gas is given off. Strips of paper should be placed on the floor of the room to be fumigated, allowing about 9 square feet of floor space for each pound of calcium cyanide required. Certain brands of calcium cyanide are marketed in cans with a top designed to assist in spreading the material on the paper runners. The gas is evolved rather rapidly from the calcium cyanide, and it is necessary for the operator to wear a gas mask at all times while applying this fumigant.

High-grade calcium cyanide is reported to contain from 50 to 55 percent of available hydrocyanic acid gas and the low-grade from 23 to 29 percent; however, some of this gas may be retained by the residue. If the material contains 50 percent of available hydrocyanic acid, 16 ounces will give a dosage equivalent to 8 ounces of liquid HCN. Therefore, twice as many ounces of high-grade calcium cyanide should be used as are given for the corresponding dosage of liquid hydrocyanic acid in Table 1.

Carbon disulphide

Experiments with carbon disulphide have shown that at temperatures of 70° F., or above, a dosage of 10 pounds of the liquid per 1,000 cubic feet gave effective results in the fumigation of tobacco hogsheads. This gas is inflammable and explosive in concentrations of 2 pounds or more per 1,000 cubic feet. The use of large quantities of this material often invalidates fire insurance policies, and its use for the fumigation of large tobacco warehouses is not recommended. The Southeastern Board of Fire Underwriters permits its use under a set of regulations designed to safeguard the premises against fire during the fumigation.

Comparative dosage of fumigants

There is considerable confusion in the minds of many tobacco dealers and manufacturers regarding the dosage of the different commercial brands of fumigants to use for effective fumigation. It is considered desirable to include a tabulation in this paper giving the equivalent dosages of fumigants for effective results based on the effective dosages of liquid HCN given in Table 1. Data have been obtained on the effectiveness of high and low grade calcium cyanide in the fumigation of stored tobacco. The dosages given in Table 2 are based on the experimental data accumulated.

Table 2. - Comparative dosages of fumigants (per 1,000 feet of space) for killing all stages of the cigarette beetle, compiled from data obtained in the fumigation of tobacco warehouses, with maximum temperatures ranging from 70° to 90° F. and minimum temperatures ranging from 60° to 70° F., 1930 to 1933

Hydrocyanic acid (liquid) 95 to 98% HCN	High-grade calcium cyanide (granular) 50 to 55% HCN	Low-grade calcium cyanide (granular) 23 to 29% HCN	Sodium cyanide (crystalline) 42% HCN
Ounces	Ounces	Ounces	Ounces
6	12	24	14
10	20	40	24
16	32	64	40
20	40	80	50

When calcium cyanide is distributed in tobacco warehouses, a small amount of gas is sometimes retained in the residue. In estimating the dosages, based on liquid HCN, shown in Table 2, high grade calcium cyanide was rated at 50 percent and low grade at 25 percent of liquid HCN. The yield of hydrocyanic acid gas from sodium cyanide generated by the "pot" or "barrel" method according to the formula 1-1½-2 was rated at 42 percent of that of liquid hydrocyanic acid.

Resistance of the tobacco moth to fumigation with hydrocyanic acid gas

When test lots of larvae of the cigarette beetle and the tobacco moth were fumigated under identical conditions, the moth larvae showed a greater resistance to the gas. To illustrate this fact, a summary of 2 fumigation experiments, when a dosage of 10 ounces of hydrocyanic acid per 1,000 cubic feet of warehouse space was applied, is given on Table 3.

Table 3. - Comparative results of fumigating 80 test lots of larvae of the tobacco moth and the cigarette beetle with hydrocyanic acid (10 ounces per 1,000 cubic feet) in 1933

Date	Numbers of test lots1/	Location	Average percent killed		Difference in percent killed
			Tobacco moth	Cigarette beetle	
June 28	24	Surface beneath staves	70.3	86.6	13.3
	24	3 inches in hogshead	70.8	88.7	17.9
Nov. 11	16	Surface beneath staves	92.5	99.3	6.8
	16	3 inches in hogshead	63.7	99.4	35.7

1/ Each lot contained 5 tobacco moth larvae and 10 cigarette beetle larvae.

These data show that the tobacco moth is more difficult to control in tobacco warehouses than the cigarette beetle. Although the tobacco moth is not as widespread as the cigarette beetle, warehouses infested with the moth should be fumigated at intervals until the infestation is under control. A fumigation schedule based on the dosages shown in Table 1 will often eliminate the cigarette beetle from storages of flue-cured tobacco and yet leave a considerable number of moths surviving the one or more fumigations during the season.

Fumigation schedule

Since in atmospheric fumigation it is impossible to secure a penetration deeper than from 3 to 6 inches in tobacco hogsheads and cases of flue-cured tobacco, it is desirable to time fumigations to correspond with the emergence of the broods of insects. In most instances larvae of the tobacco moth migrate to the surface of the tobacco or leave the cask entirely in order to pupate. Cigarette beetle larvae also migrate to some extent. The adults of both species mate on the surface of the hogsheads and cases or on the walls of the warehouse prior to egg laying, and remain outside or near the surface of the tobacco during the period of their life, which is approximately two weeks in summer. To kill the adults, therefore, no penetration is required. The emergence of the different broods during the active season can be determined rather accurately by the use of indicators.

The cigarette beetle shows a decided attraction to light, and the tobacco moth is attracted to a lesser degree. A suitable indicator consists of a fabricated board 16 inches long, 10 inches wide, and $\frac{3}{8}$ inch thick, on which a sheet of sticky fly paper 14 inches long and 8 inches wide is attached with thumb tacks. The indicator is shown in Figure 3.

Indicators should be suspended at an angle of about 45 degrees and six inches below electric lights in tobacco warehouses. One indicator for each 50,000 to 75,000 cubic feet of tobacco storage is sufficient. It is recommended that 40-watt light bulbs be used over the indicators and that only the lights over the indicators be allowed to burn during the night.

The following plan of insect control is suggested for the closed-type flue-cured tobacco warehouse:

1. Place indicators in tobacco warehouses prior to the emergence of the spring brood; the catches of tobacco insects will serve as an indication of emergence. (These indicators should be placed in operation in the bright-tobacco belt about May 15.)

2. When 50 adults of the cigarette beetle, or 30 adults of the tobacco moth, are caught per week per indicator in flue-cured tobacco storages, fumigate the infested warehouse with hydrocyanic acid gas. For dosages consult Table 1; usually however, a dosage of 10 ounces of liquid hydrocyanic acid per 1,000 cubic feet is sufficient for this degree of infestation.

3. Fumigate from May to November whenever the indicators show the presence of adults of tobacco insects.

Cost of fumigation with hydrocyanic acid

Accurate records of costs for the fumigation of 16,815,000 cubic feet of tobacco warehouses, using a dosage of 10 ounces of liquid hydrocyanic acid per 1,000 cubic feet, show that these costs were as follows:

Total cost for labor used in sealing storages	$1,103.75
Total cost of materials for sealing	715.22
Total cost of liquid HCN (85 cents per pound)	8,933.50
Service charges of commercial fumigator	1,500.00
Average total cost per hogshead for fumigation	.097
Average total cost per 1,000 cubic feet of storage	.71

It is fair to assume that a hogshead of flue-cured tobacco, containing 1,000 pounds, has a value of $250. It can be seen from the above summary of costs that the expenditure of 9.7 cents per hogshead for fumigation is not an excessive charge. The hydrocyanic acid applied is the greatest single item of cost in fumigation, often amounting to over 80 percent of the total cost.

Liquid hydrocyanic acid can be purchased at 85 cents per pound in large lots and $1 per pound in small lots. High-grade calcium cyanide can be purchased in 25-pound cans at $1 per pound, while low-grade calcium cyanide is quoted at 30 cents per pound (September 1934). The price of sodium cyanide in crystalline form is quoted at 16½ cents in 100-pound lots, and commercial grades of sulphuric acid (H_2SO_4), for use with this material in fumigation, at 4 cents per pound. The following is a comparison of the cost of fumigants, based on the prices given above, allowing a dosage of 16 ounces of liquid HCN, or its equivalent, per 1,000 cubic feet: liquid HCN 85 cents; high-grade calcium cyanide $2; low-grade calcium cyanide $1.20; and sodium cyanide and sulphuric acid 46¼ cents. Tobacco warehouses are usually equipped with a system of pipes and nozzles for the application of liquid HCN at a cost of approximately 10 cents per 1,000 cubic feet for labor and materials. This installation can be used for a long period of years if the pipes are protected against debris clogging the line. When sodium cyanide is used in combination with sulphuric acid and water to fumigate by the "crock" or "barrel" method, there is an additional cost for crocks or barrels and for the tubs to safeguard against leakage of the acid-water mixture. The cost of these materials will vary in different localities and to some extent with the quantity purchased. Cost records were kept on tubs, barrels, and other equipment; the cost varied from 20 to 30 cents per 1,000 cubic feet fumigated. This would increase the cost per 1,000 cubic feet for this method to from 66¼ to 76¼ cents, which does not include the cost of labor involved in disposing of the residue and washing crocks and barrels.

Temperature

For most satisfactory results in the fumigation of tobacco warehouses, the temperature of the building and its contents should be 70° F. or above (see Table 1). This means that the fumigation program must ordinarily be carried out between June 1 and October 1 in the bright-tobacco belt. If fumigation is to be effectively carried out during the colder months of the year, heat must be provided in the space to be fumigated and the temperature brought up to 70° F. or above. At these temperatures hydrocyanic acid gas and other tobacco fumigants are more active, and the stages of cured-tobacco insects are more susceptible to the gases. The insects are inactive or very sluggish at temperatures below 60° and are dormant at 50° F. or below. In this inactive or dormant stage they are extremely difficult to kill with fumigants.

Exposure

As shown in Table 1, the minimum exposure recommended is 48 hours. It is likely that most of the hydrocyanic acid gas will escape from the storages before the expiration of this time. However, until more accurate information on the concentration of gas at varying intervals after fumigation is obtained, it is believed advisable to give an exposure of 48 hours when dosages of from 10 to 14 ounces per 1,000 cubic feet are used. When dosages of 16 ounces of liquid hydrocyanic acid, or greater, are used per 1,000 cubic feet, it is recommended that an exposure of 72 hours be given. Experiments to date indicate that the 72-hour exposure operates to reduce the number of insects which revive from the effects of the gas; however, additional observations will be made to determine the benefits to be derived from the longer exposure. Most warehouse fumigations occur over the week-ends; i. e., from Friday to Monday, when the fumigation provides the minimum of interference with normal warehouse operations.

Safeguards to employ in fumigation

If fumigation of tobacco warehouses is to be successful, the work must be properly planned and carried out. All fumigators must be equipped with gas masks when applying hydrocyanic acid. Data concerning suitable masks can be obtained from the manufacturers of this fumigant. Fumigators should notify the local fire department before the gas is released and should cooperate fully with city officials in carrying out regulations designed to safeguard lives and property.

A careful search should be made to make sure that all persons are out of the building before a fumigation is started. Conspicuous signs should be placed on the doors of the warehouse under fumigation, and watchmen should be provided to keep people and domestic animals away until the building has been ventilated. A minimum of 12 hours should be given for the ventilation of tobacco storages, and in damp or cloudy weather this period must be extended. The trained fumigator should inspect the warehouse and notify the owners when it is safe to enter and resume work.

If persons should be overcome from breathing the fumes of gases mentioned in this paper, they must be taken into fresh air as soon as possible and a physician should be called. In the case of cyanide poisoning, fresh air must enter the lungs as in normal respiration if the victim revives. If the person is breathing normally, it is ordinarily sufficient to carry him into the open air. It is advisable for fumigators to have at all times a supply of ammonium carbonate, the fumes of which when breathed assist in recovery from exposure to hydrocyanic acid gas. If breathing has stopped or is irregular, artificial respiration should be employed. One of the best known means of artificial respiration is Schafer's prone pressure method. The details of this method of resuscitation are too extensive to publish in this paper, but those using hydrocyanic acid should request the manufacturers to supply them with details of the method. All fumigators should be familiar with the proper technic of artificial respiration and with the use of the best known antidotes for the gases used in fumigation.

Explanation of illustrations

Figure 1. - Section of tobacco warehouse being fumigated with liquid hydrocyanic acid. Note the sealing of the ventilators with gas-proof paper and the sliding door with a mixture of asbestos (4 parts), calcium chloride (1 part), and water. The ½-horsepower motor is used to place about 100 pounds of pressure on the liquid, which is forced through the pipes and nozzles into the storage.

Figure 2. - Fifty-gallon wooden barrel in which oil has been stored. This is the most satisfactory type of container for fumigations using sodium cyanide. The tub contains a few inches of water, with baking soda added to neutralize the acid if any boils over.

Figure 3. - Indicator of the presence of cigarette beetles and tobacco moths in tobacco warehouses. Note that the board hangs 6 inches below the electric light, at an angle of 45°.

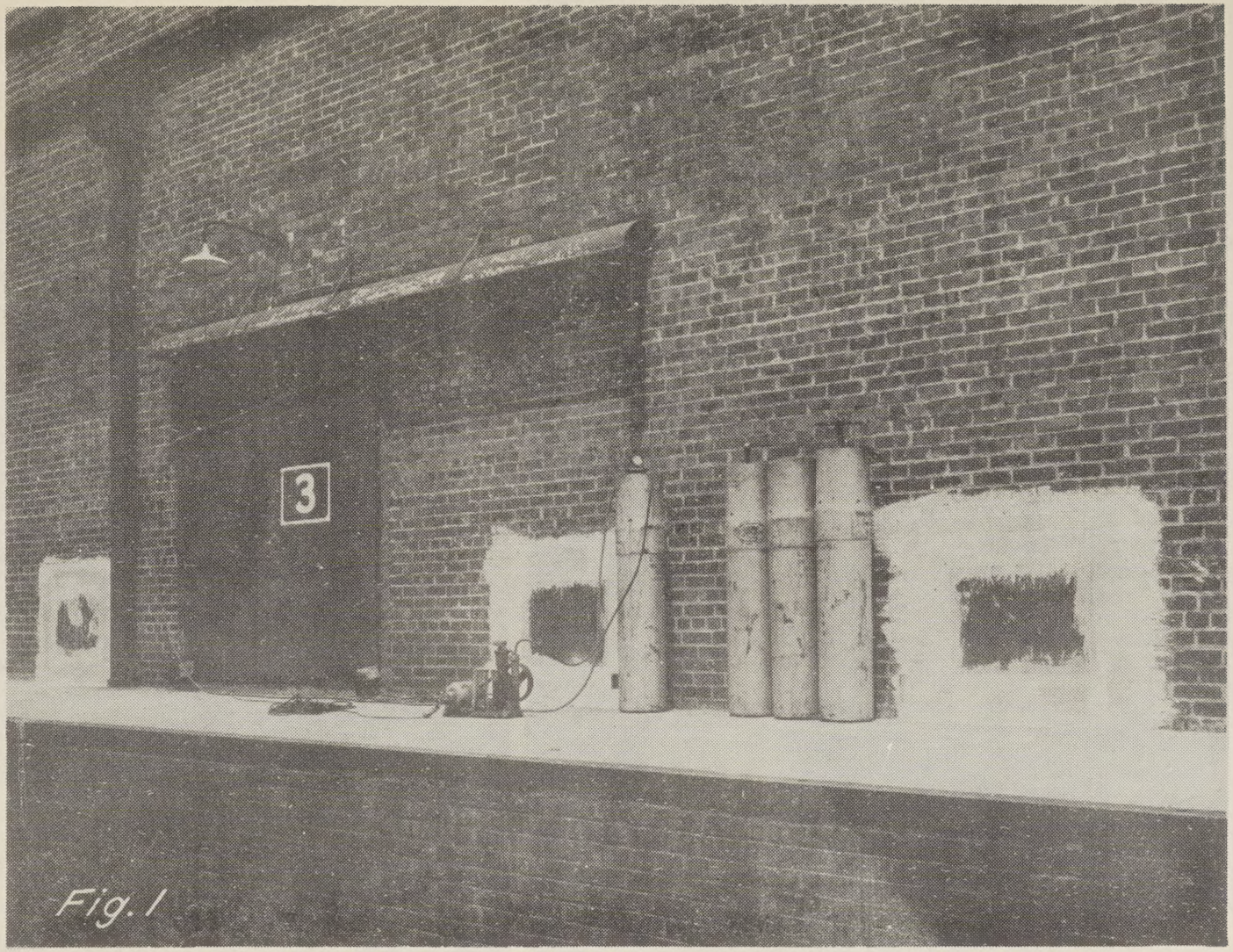

Fig. 1

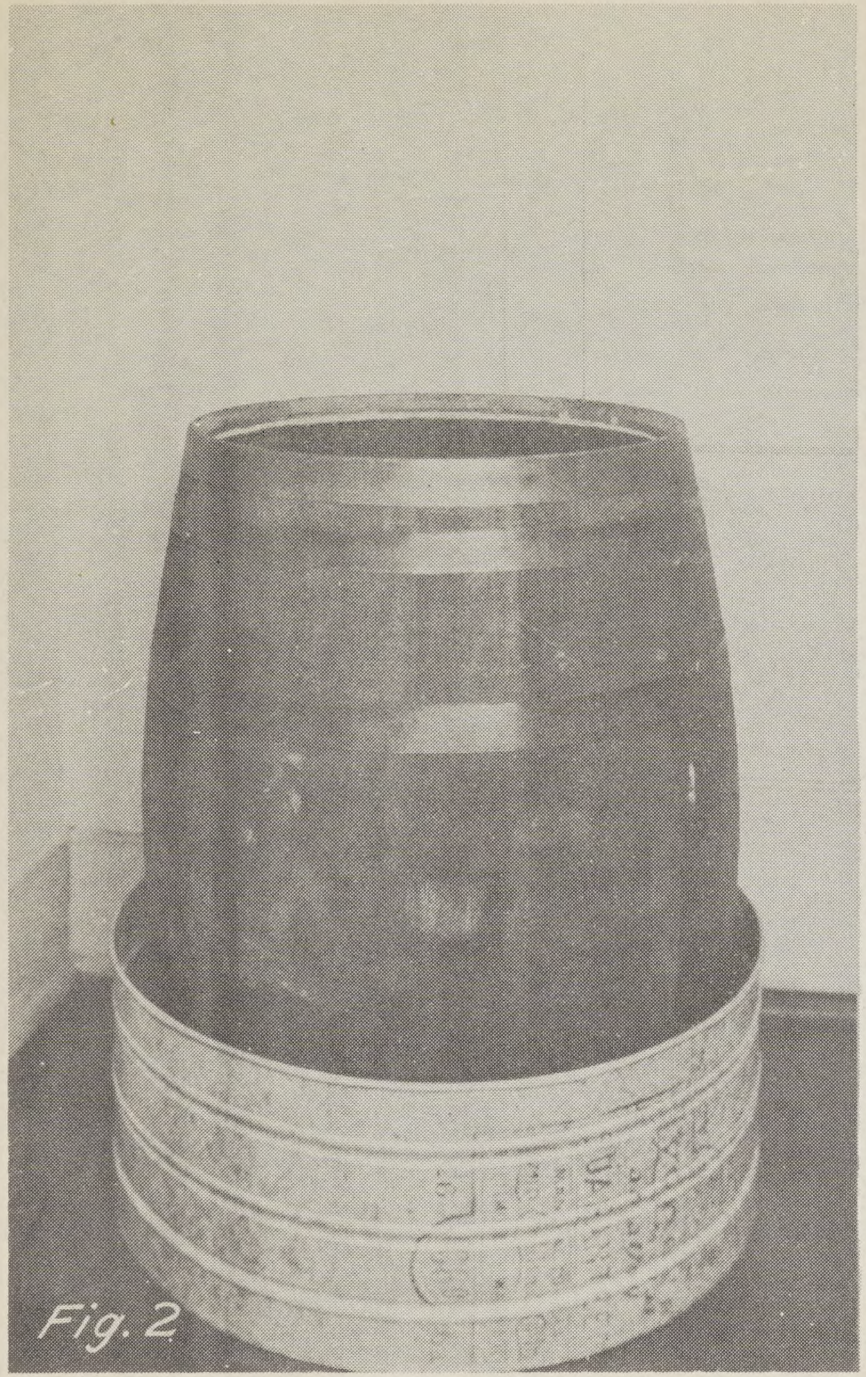

Fig. 2

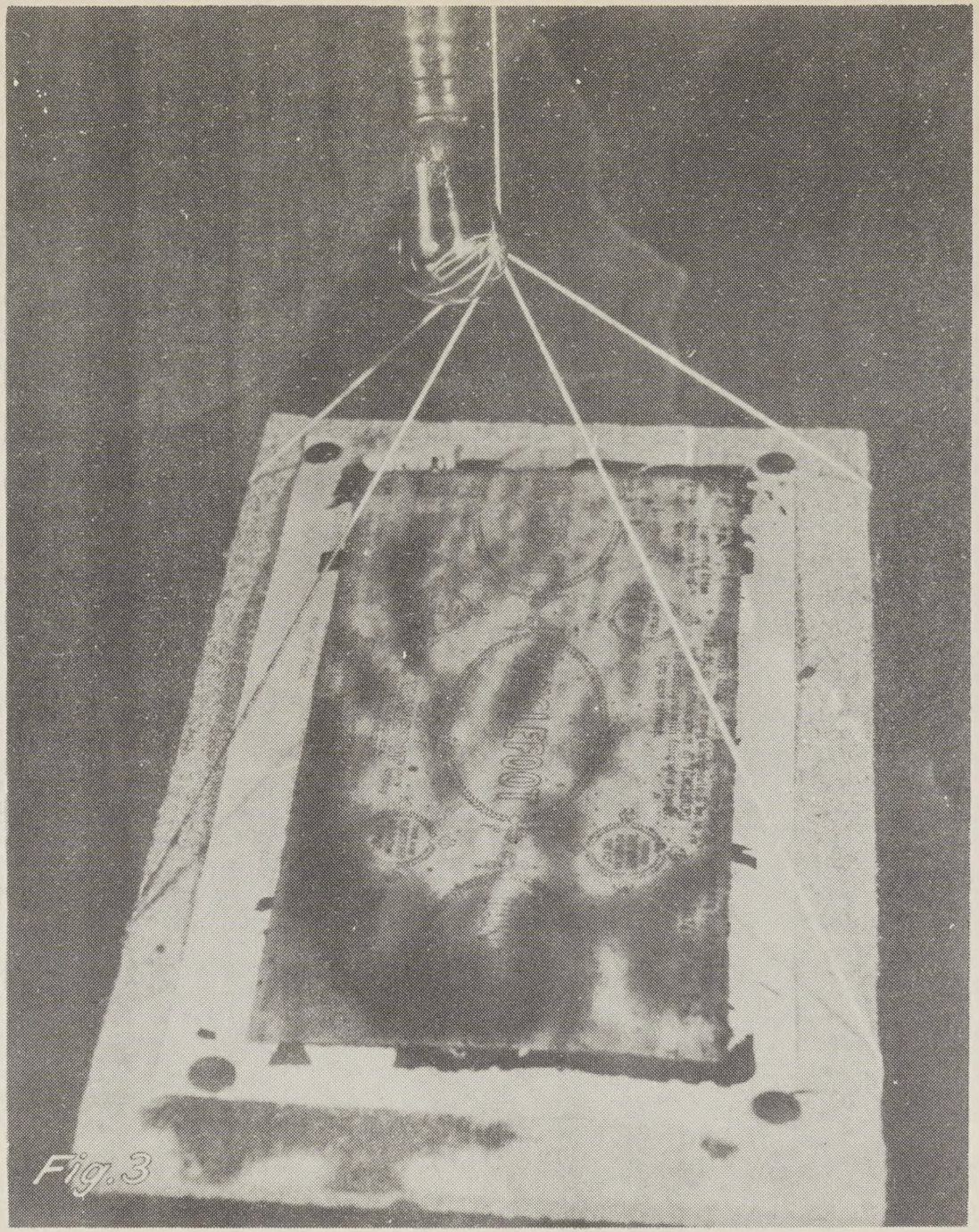

Fig. 3